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Tanaka

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(54) **CLEANING DEVICE, CHARGING UNIT, IMAGE BEARING UNIT, AND IMAGE FORMING APPARATUS**

(75) Inventor: **Arichika Tanaka**, Kanagawa (JP)

(73) Assignee: **Fuji Xerox Co., Ltd.**, Tokyo (JP)

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G03G 15/02 (2006.01)

(52) **U.S. Cl.**
USPC **399/100**; 399/170; 399/171

(58) **Field of Classification Search**
USPC 399/100, 170
See application file for complete search history.

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Primary Examiner — Walter L Lindsay, Jr.
Assistant Examiner — David Bolduc
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

A cleaning device includes a device body, a cleaning member, and a support member. The device body is moved in a longitudinal direction of a plate-like grid member of a charging device. The cleaning member is disposed in the device body and cleans a first face of the grid member while pressing against the first face when the device body is moved. The support member is provided in the device body and has a support surface that is in contact with and supports a second face opposite to the first face of the grid member pressed by the cleaning member. The support surface is in contact with a mesh portion and a non-mesh portion of the grid member.

6 Claims, 8 Drawing Sheets

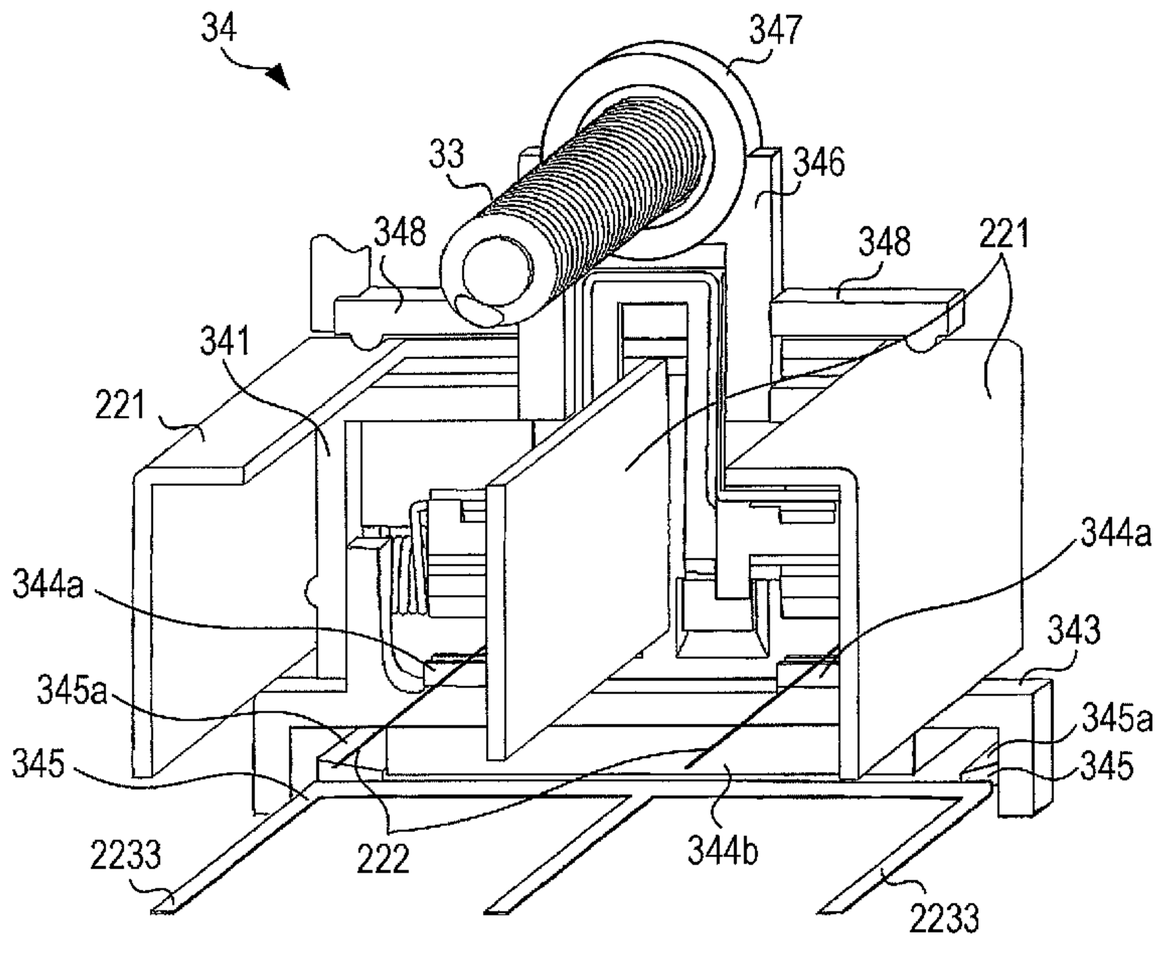


FIG. 1

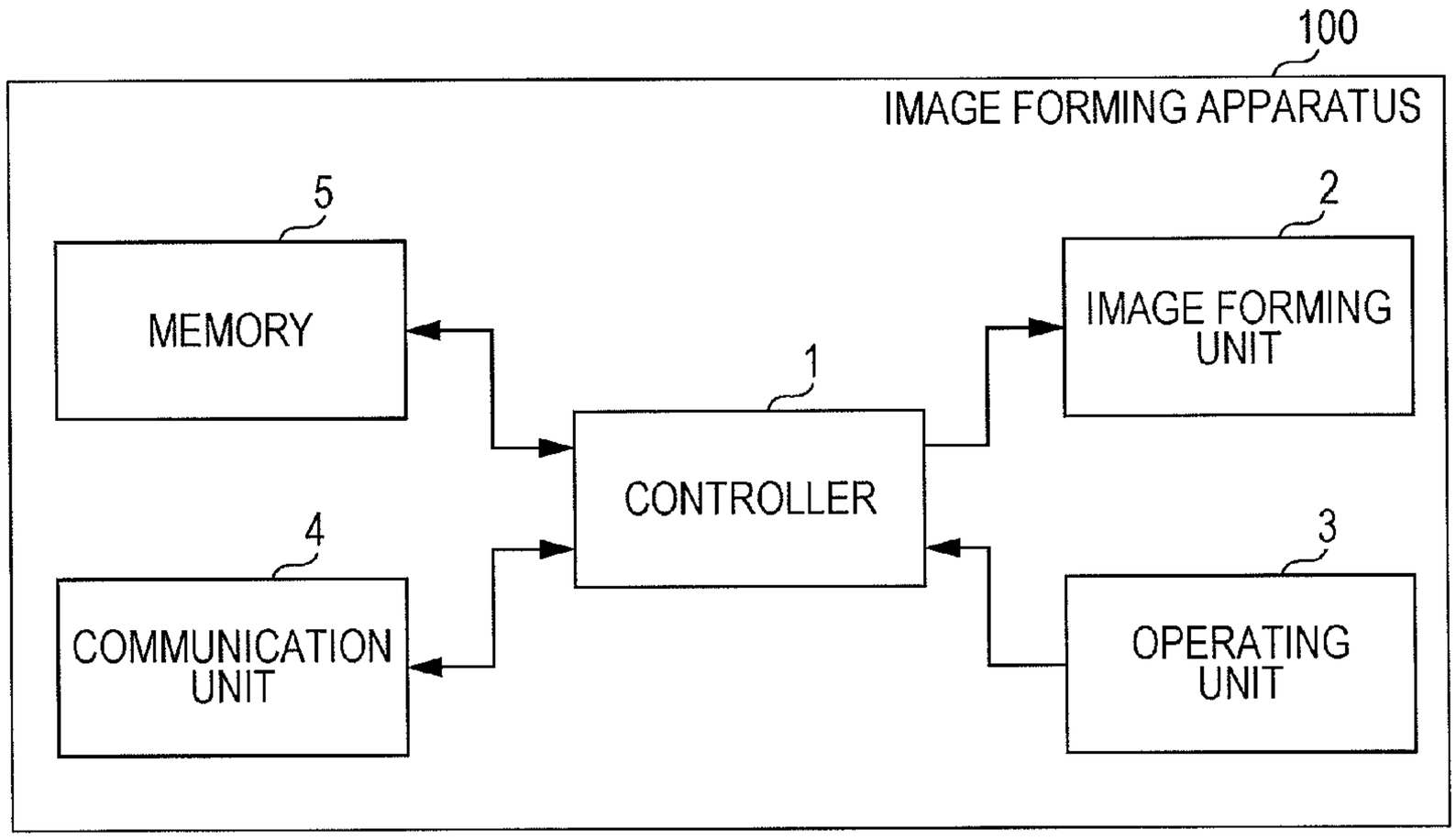

100
IMAGE FORMING APPARATUS
5
MEMORY
2
IMAGE FORMING UNIT
1
CONTROLLER
4
COMMUNICATION UNIT
3
OPERATING UNIT

FIG. 2

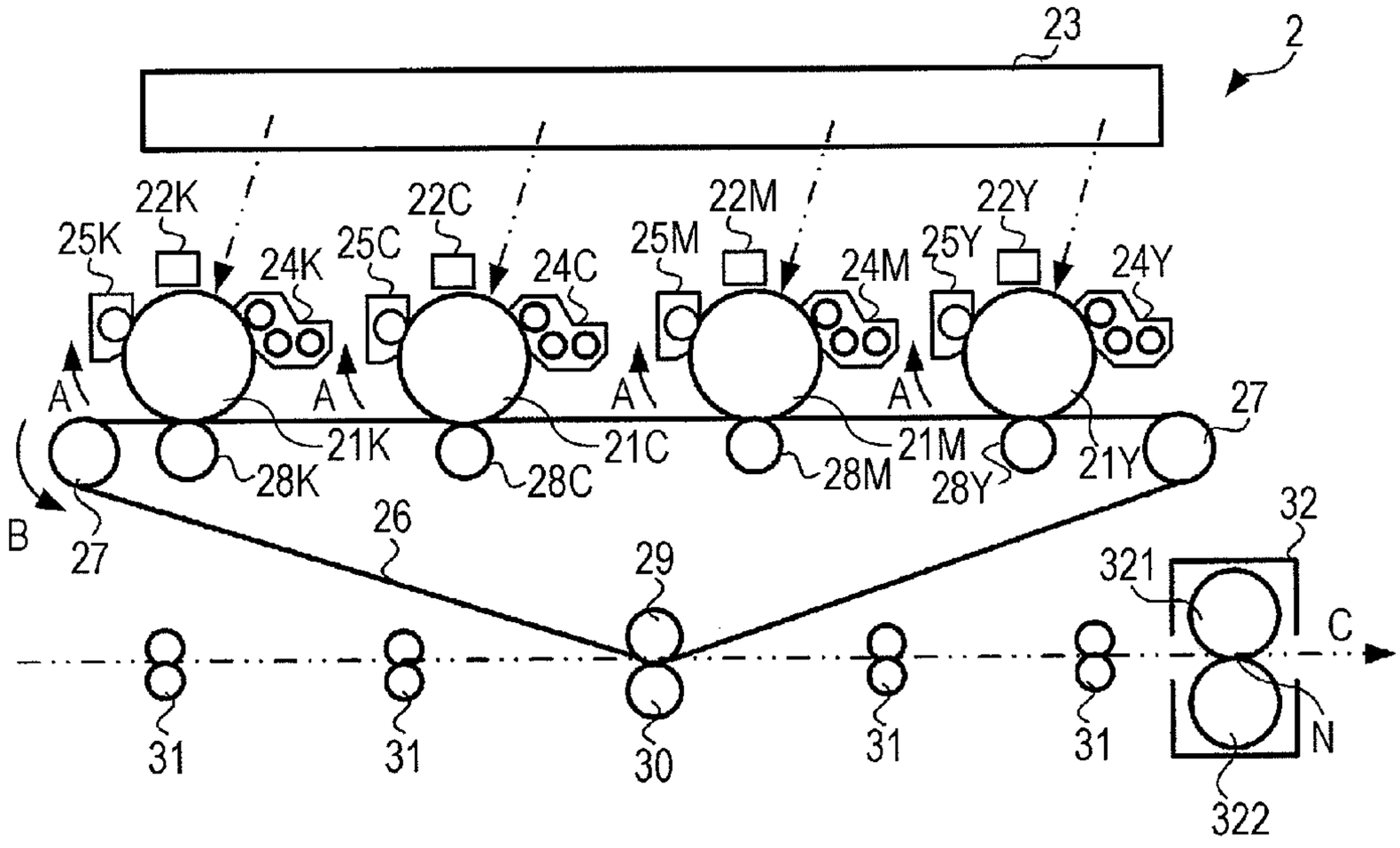

23
2
22K
25K
24K
22C
25C
24C
22M
25M
24M
22Y
25Y
24Y
A
21K
21C
21M
21Y
28K
28C
28M
28Y
27
B
26
29
32
321
C
N
322
31
30

FIG. 3

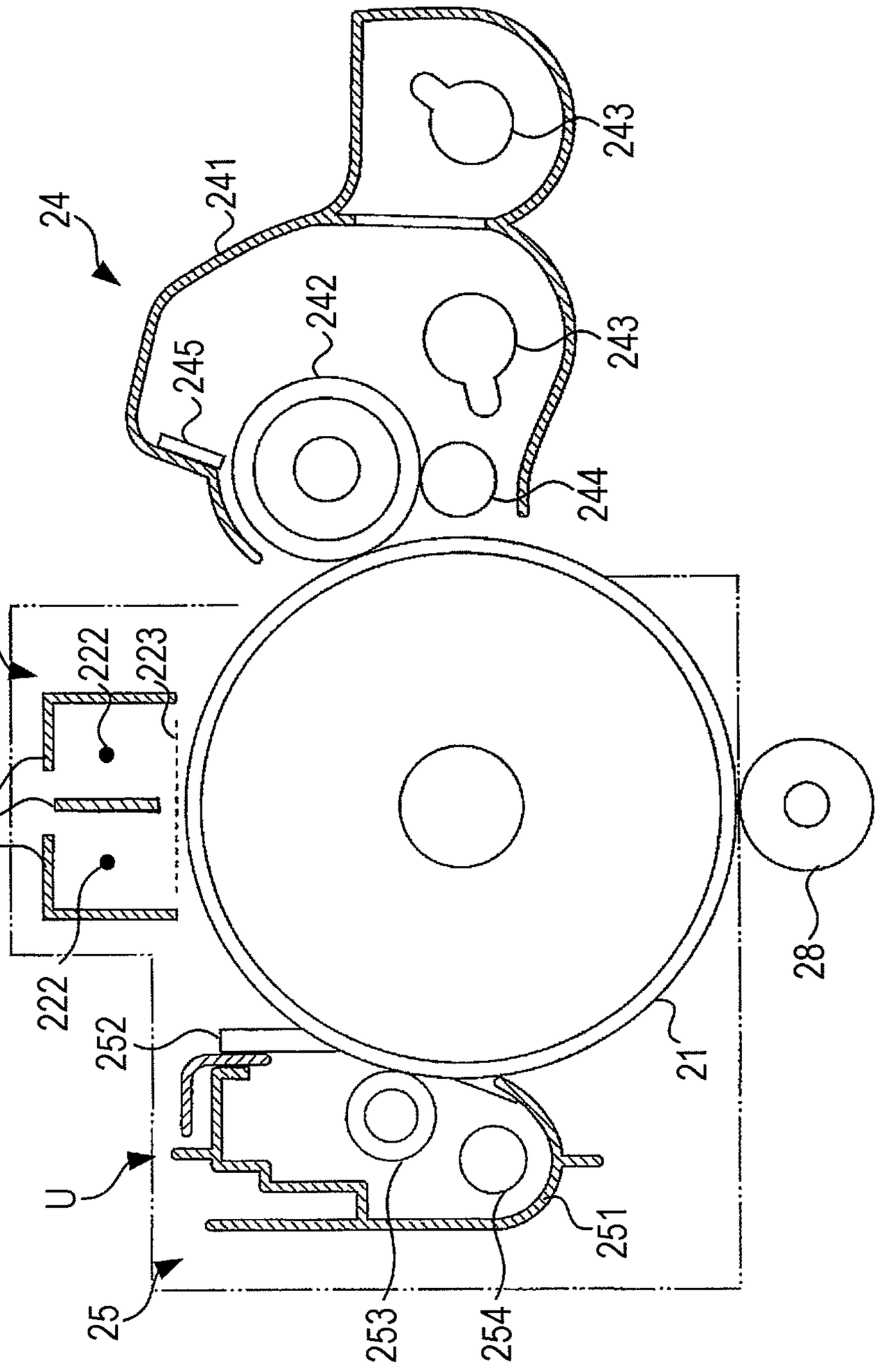

24
241
243
242
245
244
22
222
223
221
222
252
U
25
253
254
251
21
28

FIG. 4

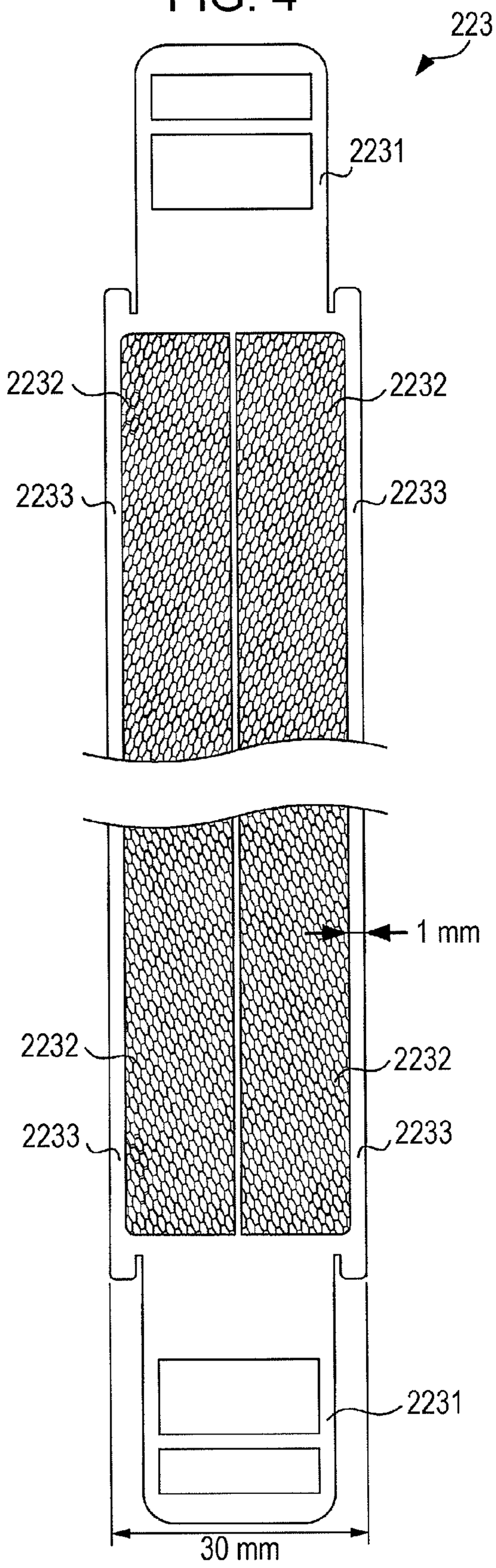

223
2231
2232
2232
2233
2233
1 mm
2232
2232
2233
2233
2231
30 mm

FIG. 5

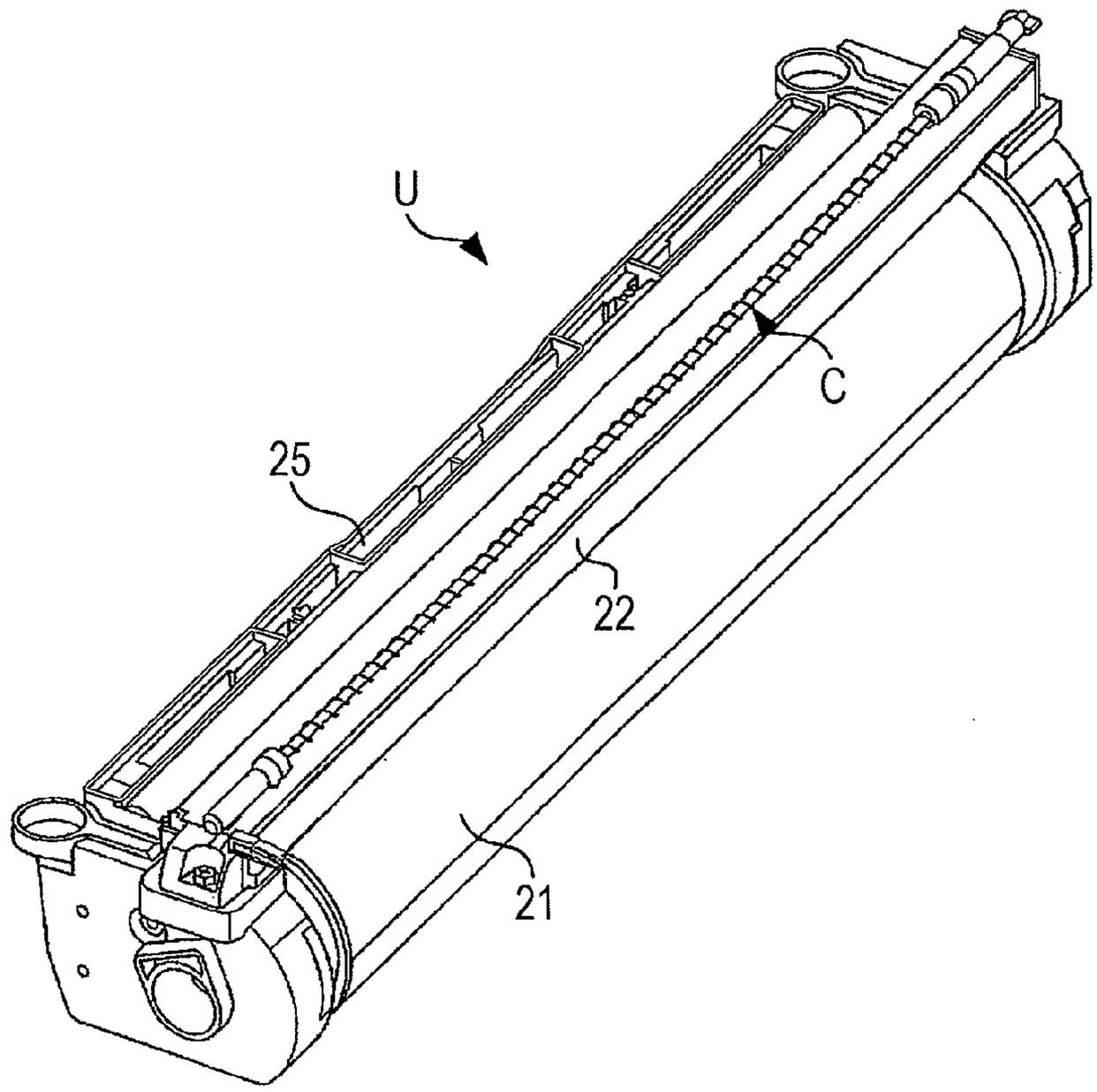


FIG. 6

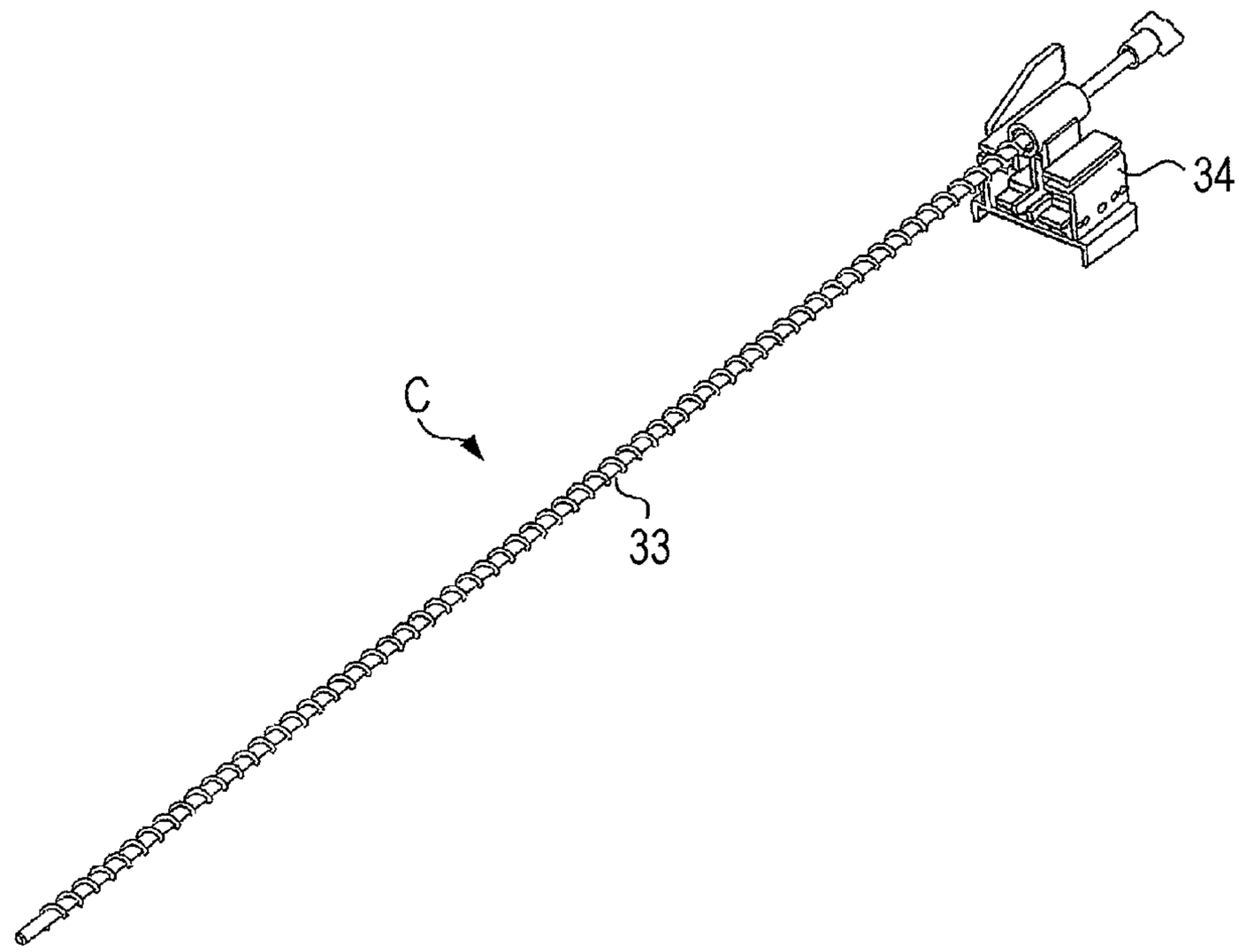


FIG. 7

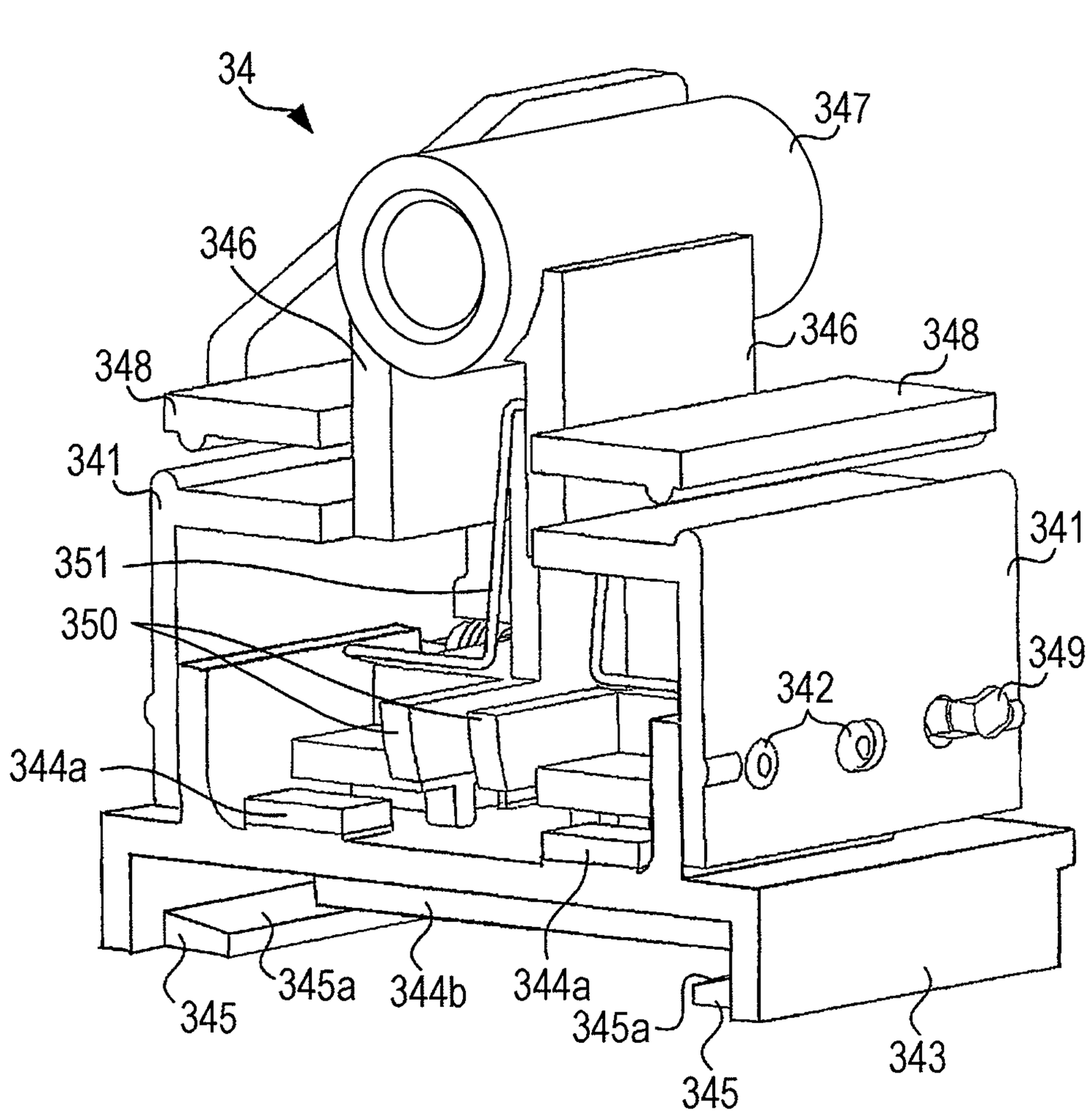

34
347
346
346
348
348
341
341
351
350
349
342
344a
345
345a
344b
344a
345a
345
343

FIG. 8

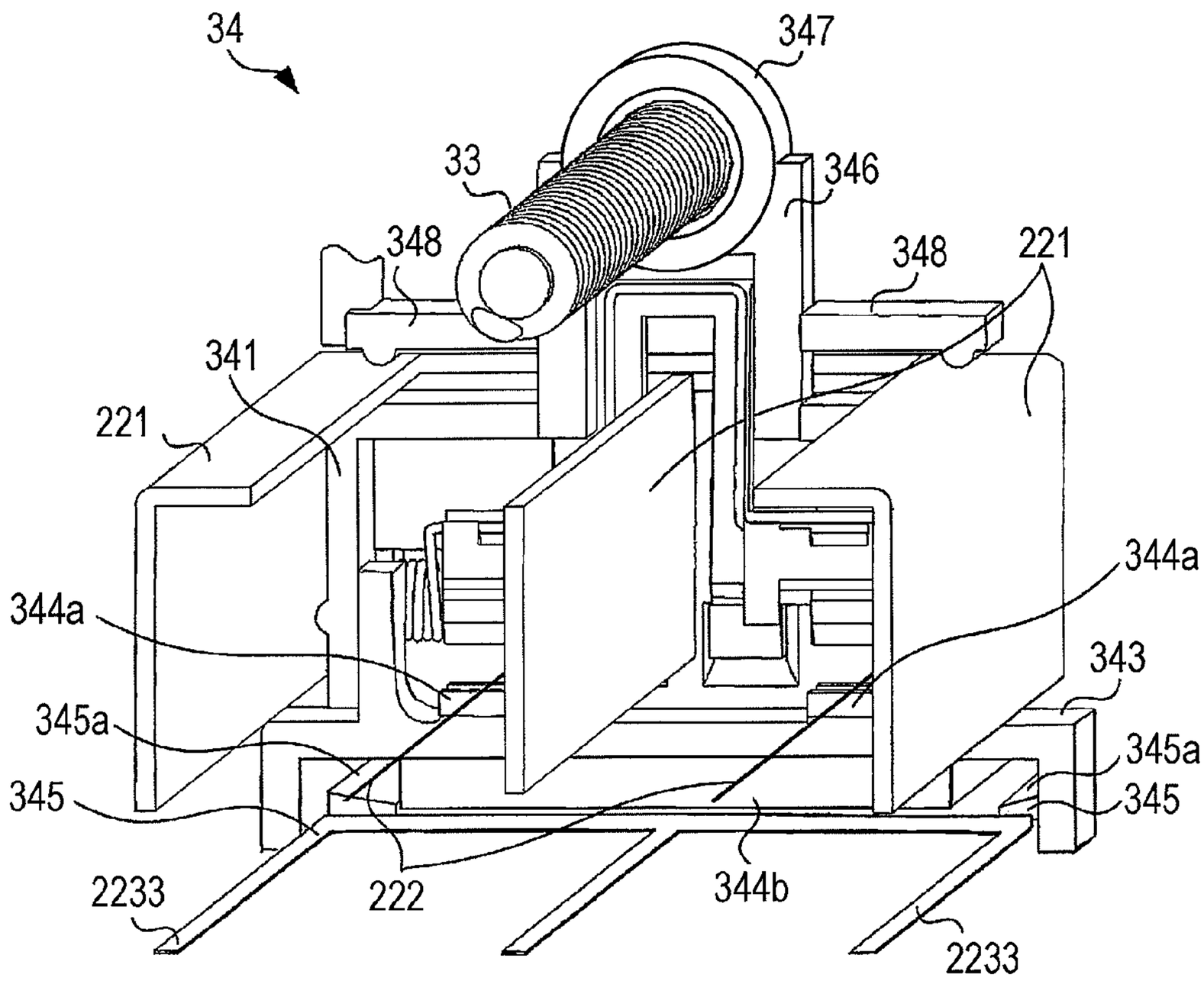

34
347
33
346
348
348
221
341
221
344a
344a
343
345a
345a
345
345
2233
222
344b
2233

FIG. 9

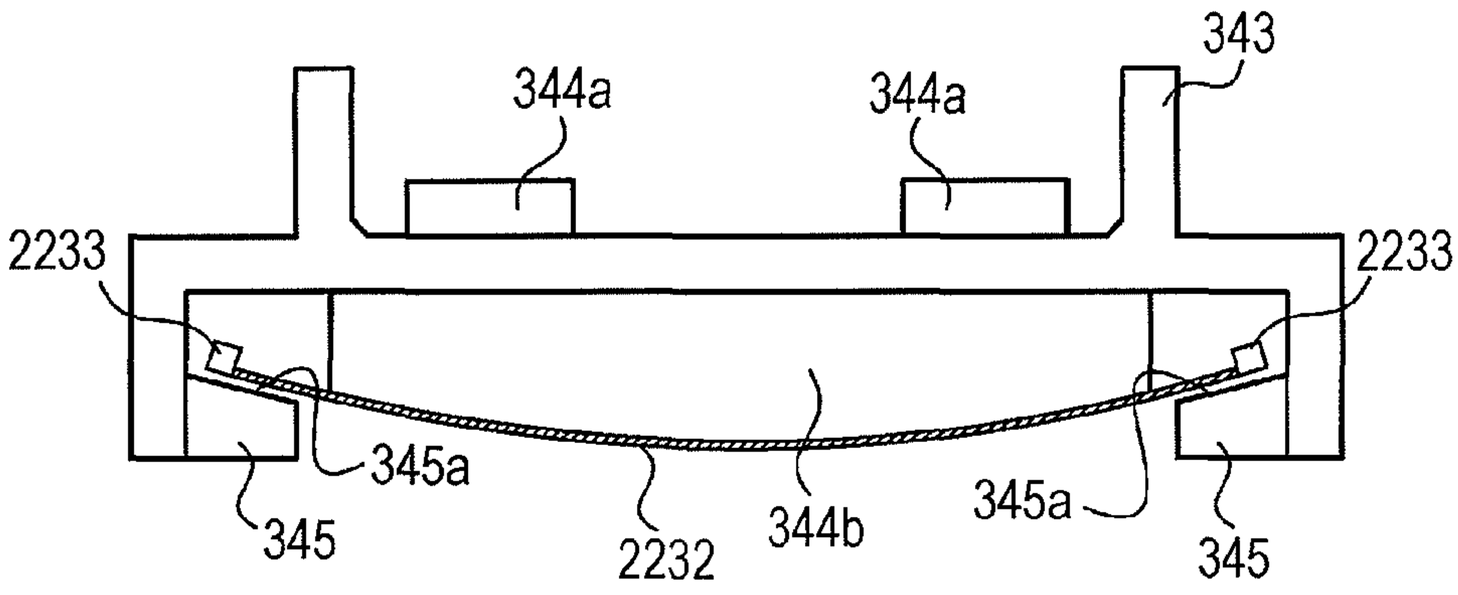


FIG. 10

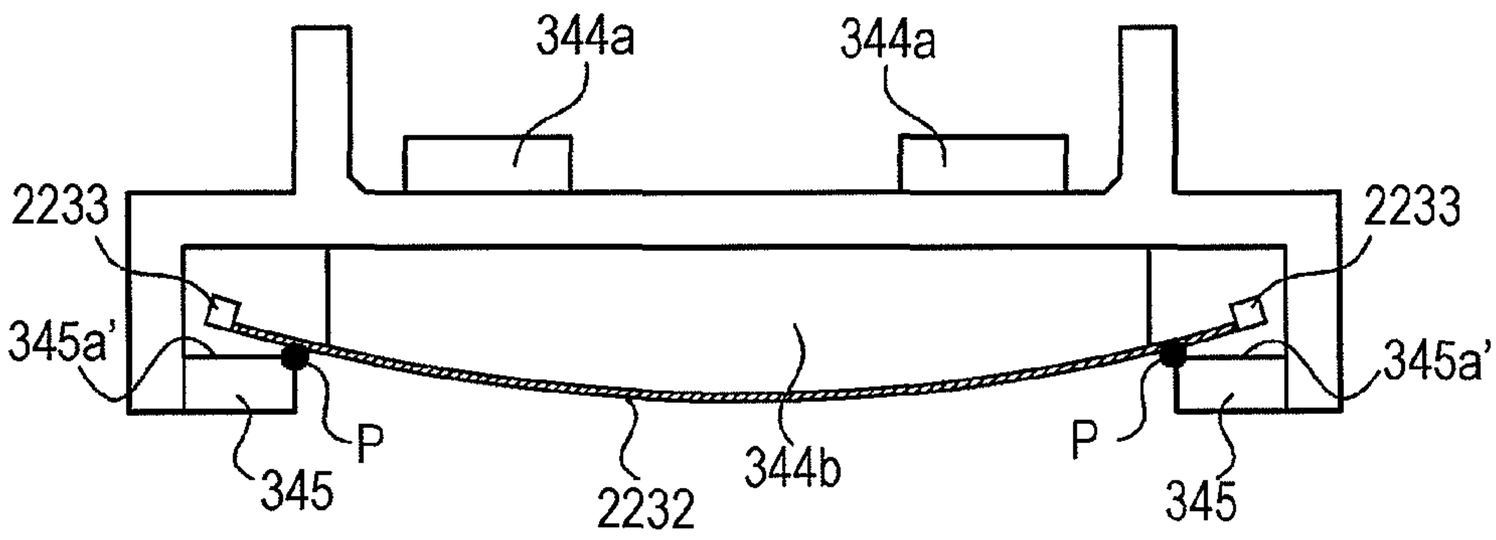


FIG. 11

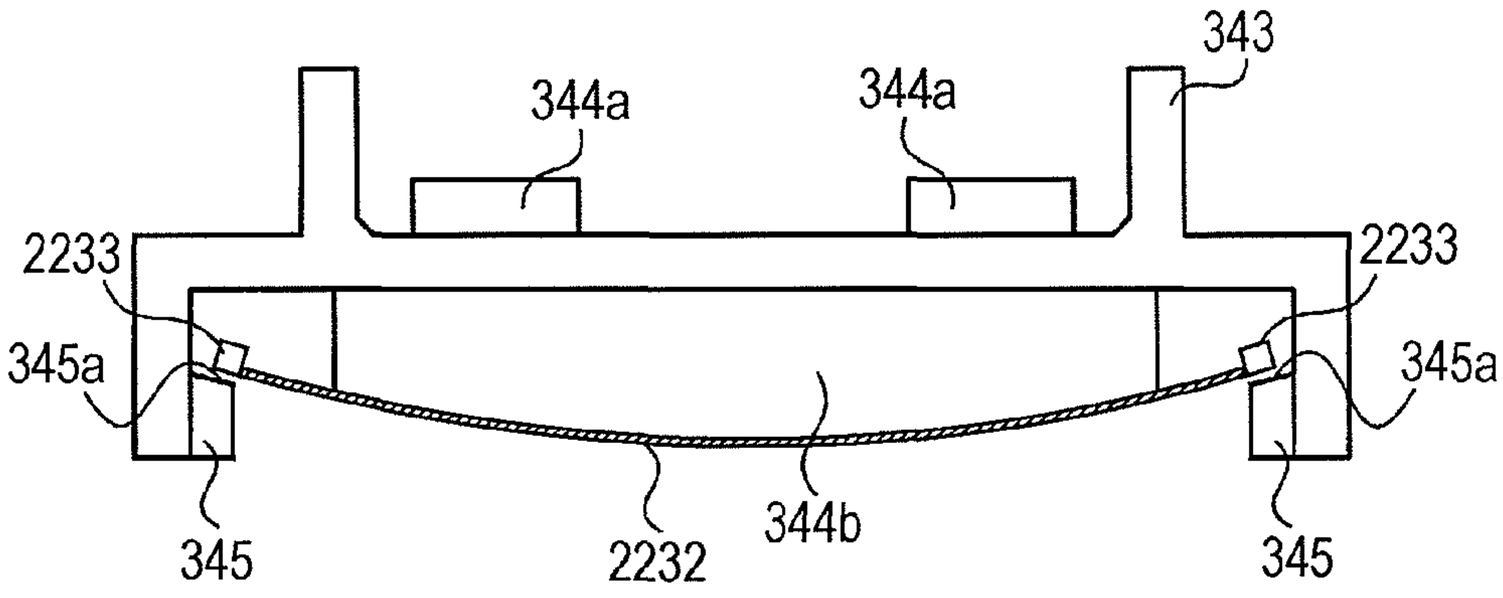


FIG. 12

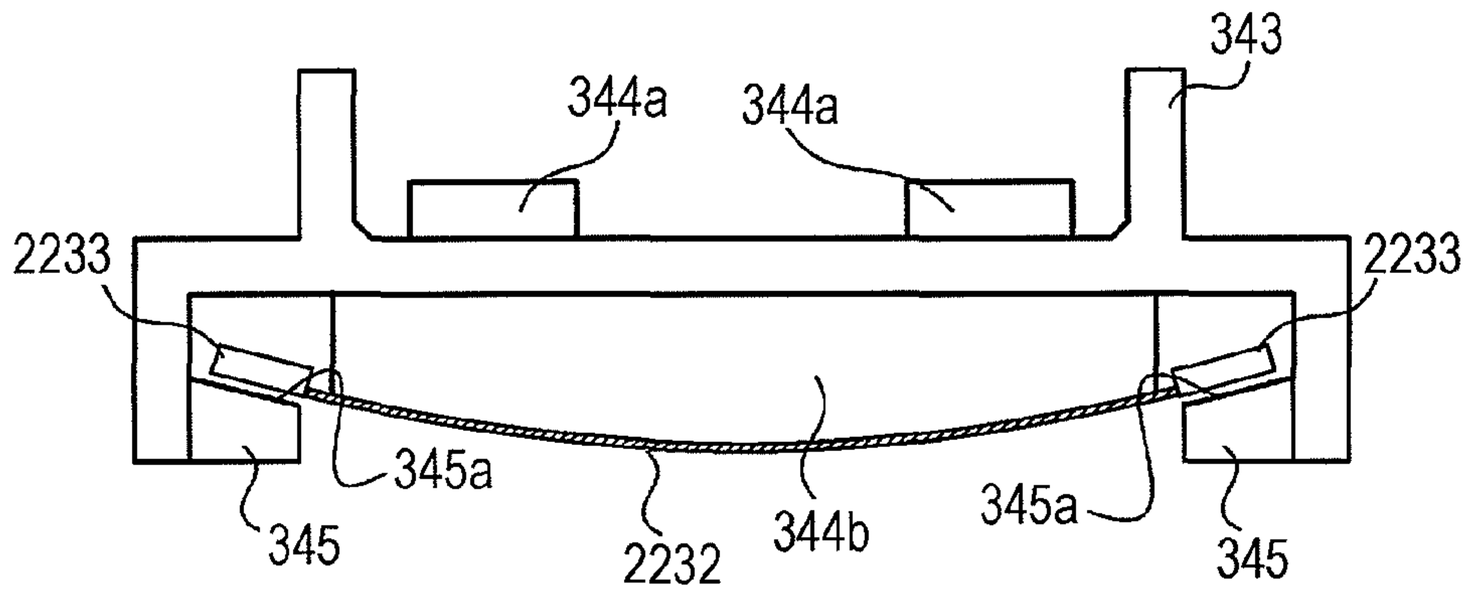


FIG. 13

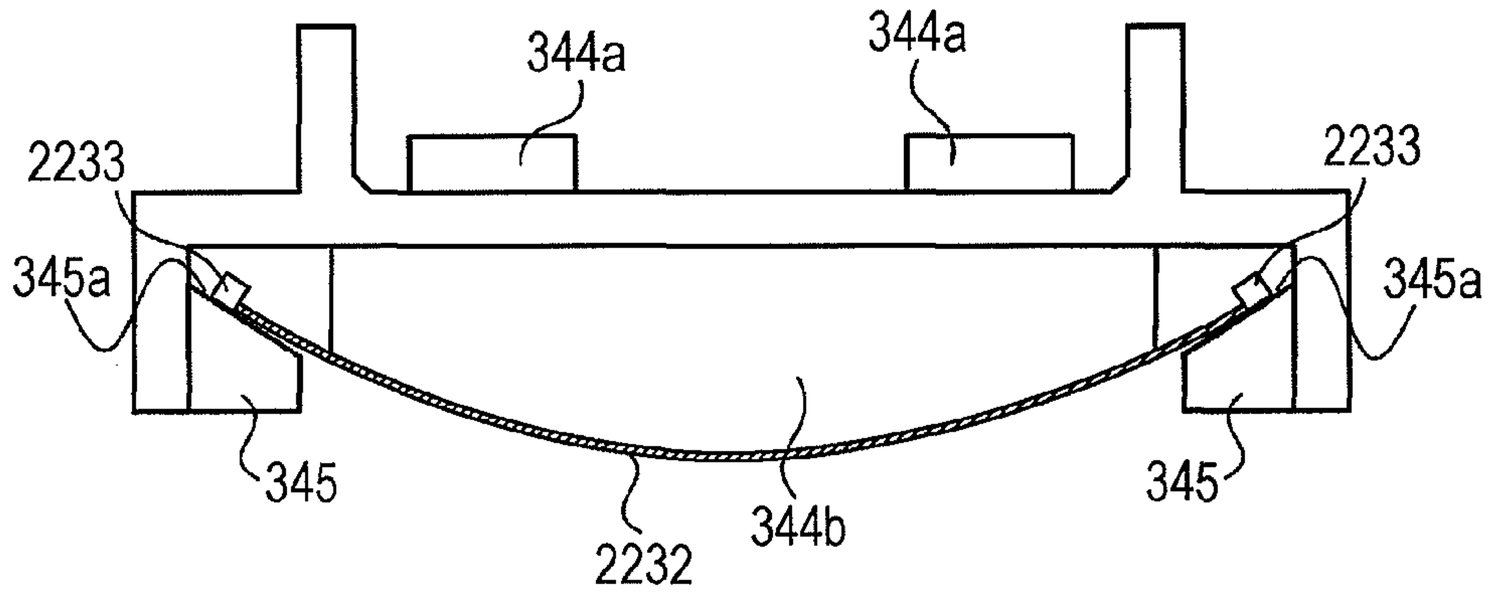
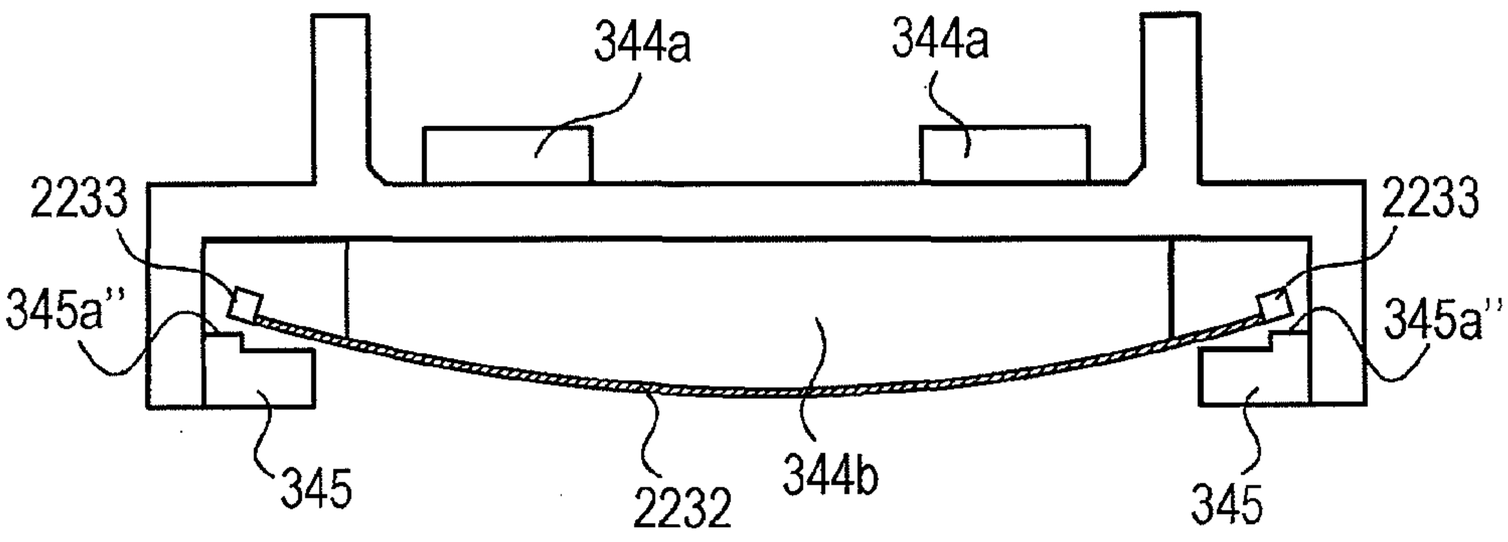


FIG. 14



CLEANING DEVICE, CHARGING UNIT, IMAGE BEARING UNIT, AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2011-049109 filed Mar. 7, 2011.

BACKGROUND

(i) Technical Field

The present invention relates to cleaning devices, charging units, image bearing units, and image forming apparatuses.

SUMMARY

According to an aspect of the invention, there is provided a cleaning device including a device body, a cleaning member, and a support member. The device body is moved in a longitudinal direction of a plate-like grid member of a charging device. The cleaning member is disposed in the device body and cleans a first face of the grid member while pressing against the first face when the device body is moved. The support member is provided in the device body and has a support surface that is in contact with and supports a second face opposite to the first face of the grid member pressed by the cleaning member. The support surface is in contact with a mesh portion and a non-mesh portion of the grid member.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present invention will be described in detail based on the following figures, wherein:

FIG. **1** illustrates the configuration of an image forming apparatus according to an exemplary embodiment of the present invention;

FIG. **2** illustrates the configuration of an image forming unit;

FIG. **3** is an enlarged view of a photoconductor drum and peripheral devices thereof;

FIG. **4** illustrates an example of a grid member;

FIG. **5** is a perspective view illustrating an example of an image bearing unit;

FIG. **6** is a perspective view illustrating an example of a cleaning mechanism;

FIG. **7** is an enlarged view of a cleaning device shown in FIG. **6**;

FIG. **8** illustrates the relationship between the cleaning device and a charging device;

FIG. **9** illustrates the relationship between a cleaning member and the grid member;

FIG. **10** illustrates the relationship between the cleaning member and the grid member as a comparative example;

FIG. **11** illustrates the relationship between the cleaning member and the grid member;

FIG. **12** illustrates the relationship between the cleaning member and the grid member;

FIG. **13** illustrates the relationship between the cleaning member and the grid member; and

FIG. **14** illustrates the relationship between the cleaning member and the grid member.

DETAILED DESCRIPTION

Exemplary embodiments of the present invention will be described below with reference to the drawings.

FIG. **1** illustrates the configuration of an image forming apparatus **100** according to an exemplary embodiment of the present invention. As shown in FIG. **1**, the image forming apparatus **100** includes a controller **1**, an image forming unit **2**, an operating unit **3**, a communication unit **4**, and a memory **5**.

The controller **1** includes an arithmetic unit, such as a central processing unit (CPU), and a memory. The arithmetic unit of the controller **1** executes a control program stored in the memory so as to control each unit included in the image forming apparatus **100**. The image forming unit **2** forms an image on a recording medium by using toner as colorant. The recording medium is, for example, recording paper, but may alternatively be a plastic sheet, such as an OHP sheet, or a sheet composed of other materials. The image forming unit **2** forms an image by an electrophotographic process using toners of four colors, which are yellow (Y), magenta (M), cyan (C), and black (K).

The operating unit **3** includes an operating member, such as a button, and supplies operational information corresponding to user's operation to the controller **1**. The communication unit **4** includes an interface for exchanging data with an external device. The memory **5** includes a storage device, such as a hard disk drive (HDD), and stores, for example, image data for forming an image.

FIG. **2** illustrates the configuration of the image forming unit **2**.

In FIG. **2**, an alphabetical character given as a suffix to each reference numeral indicates the color of toner that the component given the reference numeral handles. Components with the same reference numeral but different alphabetical characters as suffixes handle different colors of toner but have the same configuration. In the following description, the alphabetical characters given as suffixes to the reference numerals will be omitted if it is not particularly necessary to distinguish between these components.

In FIG. **2**, the recording paper transported within the image forming apparatus **100** is transported in a direction indicated by a dashed arrow C, and an image is formed on this recording paper.

Each of photoconductor drums **21** is a cylindrical member with a photoconductive film formed on a surface thereof. The photoconductor drum **21** bears an electrostatic latent image formed on the surface thereof. When in contact with an intermediate transfer belt **26**, the photoconductor drum **21** rotates in a direction indicated by an arrow A about the center of the cylinder as an axis as the intermediate transfer belt **26** moves.

The photoconductor drum **21** is an example of an image bearing member according to an exemplary embodiment of the present invention.

Each of charging devices **22** is, for example, a scorotron charger and electrically charges the photoconductive film of the corresponding photoconductor drum **21** to a predetermined potential. An exposure device **23** exposes the photoconductor drum **21** electrically charged by the charging device **22** to light so as to form a latent image according to the exposure light. Each of developing devices **24** has a developer that contains a toner of one of Y, M, C, and K colors and a magnetic material, such as ferrite powder. The developing device **24** develops the latent image formed on the corresponding photoconductor drum **21** by adhering the toner thereto so as to form a toner image. Each of cleaning units **25** removes residual toner from the corresponding photoconductor drum **21**.

The intermediate transfer belt **26** is an endless belt member and rotates in a direction indicated by an arrow B while being in contact with rotating rollers **27**, first-transfer rollers **28**, and

a backup roller **29**. The rotating rollers **27** are cylindrical members that support the movement of the intermediate transfer belt **26**, and each rotate about the center of the cylinder as an axis. The first-transfer rollers **28** are cylindrical members that face the corresponding photoconductor drums **21** with the intermediate transfer belt **26** interposed therebetween. Each first-transfer roller **28** creates a potential difference with the corresponding photoconductor drum **21** so as to transfer the toner on the surface of the photoconductor drum **21** to the surface of the intermediate transfer belt **26**.

A second-transfer roller **30** transfers the image obtained as a result of the development process performed by the developing devices **24** onto the recording paper. The second-transfer roller **30** is a cylindrical member that faces the backup roller **29** with the intermediate transfer belt **26** interposed therebetween. The second-transfer roller **30** creates a potential difference with the backup roller **29** so as to transfer the toner on the surface of the intermediate transfer belt **26** onto the surface of the recording paper. Transport rollers **31** are cylindrical members that are driven by a driving device (not shown) and that transport the recording paper in the direction of the dashed arrow C shown in FIG. **2**. The transport rollers **31** are rotated so as to transport the recording paper at a predetermined transport rate.

The second-transfer roller **30** is an example of a transfer member according to an exemplary embodiment of the present invention.

A fixing device **32** includes a fixing roller **321** and a pressing roller **322**. The fixing device **32** performs a fixing process on the transported recording paper with the image transferred thereon by applying heat and pressure to the recording paper at a nip region N between the fixing roller **321** and the pressing roller **322**, thereby fixing the image onto the recording paper.

FIG. **3** is an enlarged view of each photoconductor drum **21** and peripheral devices thereof.

In FIG. **3**, the charging device **22** includes a charge container **221**, two discharge wires **222**, and a grid member **223**. The charge container **221** is disposed in a non-contact manner above the photoconductor drum **21** and extends in the axial direction of the photoconductor drum **21**. Furthermore, the charge container **221** is composed of a material that blocks off electric discharge, and substantially has an E shape in cross section that opens toward the photoconductor drum **21**.

Although the charge container **221** is formed to substantially have an E shape in cross section for accommodating the two discharge wires **222**, the charge container **221** may alternatively be formed to substantially have a U shape in cross section if the charge container **221** is to accommodate only one discharge wire **222**.

The discharge wires **222** are electrically charging wires disposed in the longitudinal direction of the charge container **221**. Each discharge wire **222** is tensely bridged between insulating members (not shown) disposed at opposite longitudinal ends of the charge container **221** by providing at least one end with a tension-applying elastic spring (not shown). Furthermore, the discharge wires **222** are connected to a discharge bias power source (not shown). The discharge wires **222** supply electric charge to the photoconductor drum **21**.

The discharge wires **222** are composed of, for example, tungsten, carbon-tungsten, or gold-plated tungsten. The discharge wires **222** each have a diameter ranging between, for example, 30 μm and 40 μm, and the tensile force thereof ranges between, for example, 30 gf and 80 gf (0.29 N and 0.78 N). The number of discharge wires **222** may be one or three or more. In place of the discharge wires **222**, sawtooth electrodes or needle electrodes may be used as discharge electrodes.

The discharge wires **222** are an example of a discharge member according to an exemplary embodiment of the present invention.

The grid member **223** is a plate-like member that is disposed in the opening of the charge container **221** at a position away from the photoconductor drum **21**. Opposite longitudinal ends of the grid member **223** are attached to end members (not shown) disposed at the opposite longitudinal ends of the charge container **221**. The grid member **223** regulates a charge amount from the discharge wires **222** so as to control the charged potential on the surface of the photoconductor drum **21**. The grid member **223** is composed of, for example, tungsten, carbon-tungsten, or gold-plated tungsten, and has a width of, for example, 30 mm.

FIG. **4** illustrates an example of the grid member **223**. As shown in FIG. **4**, the grid member **223** has a metallic plate portion **2231**, a mesh portion **2232**, and a non-mesh portion **2233**. The metallic plate portion **2231** is to be attached to the end members (not shown) disposed at the opposite longitudinal ends of the charge container **221**. The mesh portion **2232** has a repeating hexagonal hole pattern. The non-mesh portion **2233** is formed so as to extend toward the opposite longitudinal ends of the grid member **223**, and has a width of, for example, 1 mm.

The shape of the holes in the mesh portion **2232** may alternatively be rectangular, circular, or ellipsoidal.

The developing device **24** shown in FIG. **3** has a developing roller **242**, a stirring-transport member **243**, a developer supplying roller **244**, and a regulating member **245** within a developer container **241**. The developing roller **242** holds a toner on the surface thereof and transports the toner to a developing area that faces the photoconductor drum **21**. The stirring-transport member **243** stirs and transports the toner contained in the developer container **241**. The developer supplying roller **244** supplies the toner stirred and transported by the stirring-transport member **243** to the surface of the developing roller **242**. The regulating member **245** regulates a layer thickness of the toner held on the developing roller **242**.

The cleaning unit **25** shown in FIG. **3** has a cleaning blade **252**. Moreover, the cleaning unit **25** has a cleaning brush **253** and a transport member **254** within a cleaning container **251**. The cleaning blade **252** brings an edge thereof in pressure contact with the surface of the photoconductor drum **21** so as to scrape off a residue therefrom. The cleaning brush **253** brushes off the residue from the photoconductor drum **21**. The transport member **254** transports the residue removed by the cleaning blade **252** and the cleaning brush **253** outward from the cleaning container **251**.

The photoconductor drum **21**, the charging device **22**, and the cleaning unit **25** shown in FIG. **3** are integrated into a single unit as an image bearing unit U (see a two-dot chain line in FIG. **3**). FIG. **5** is a perspective view illustrating an example of the image bearing unit U. In addition to the photoconductor drum **21**, the charging device **22**, and the cleaning unit **25**, the image bearing unit U shown in FIG. **5** includes a cleaning mechanism C for cleaning the charging device **22**.

FIG. **6** is a perspective view illustrating an example of the cleaning mechanism C. As shown in FIG. **6**, the cleaning mechanism C includes a cleaner shaft **33** and a cleaning device **34**.

The cleaner shaft **33** is a rod-like member with a helical groove formed around the surface thereof. Opposite longitudinal ends of the cleaner shaft **33** are attached to the end

members disposed at the opposite longitudinal ends of the charge container **221** (see FIG. **5**). Furthermore, the cleaner shaft **33** is connected to a motor (not shown) that is rotatable in forward and reverse directions, and rotates by receiving a driving force from this motor.

FIG. **7** is an enlarged view of the cleaning device **34** shown in FIG. **6**. FIG. **8** illustrates the relationship between the cleaning device **34** and the charging device **22**. The cleaning device **34** shown in these drawings has a substantially inverted-U-shaped support frame **341** that is slidably movable in the longitudinal direction of the charge container **221**. The support frame **341** is provided with attachment holes **342** and is coupled to a cleaning member **343** via securing members inserted in the attachment holes **342**. Cleaning pads **344***a* and **344***b* are respectively attached to an upper surface and a lower surface of the cleaning member **343**. The cleaning pads **344***a* are disposed in contact with the discharge wires **222** so as to remove discharge products adhered to the discharge wires **222**. The cleaning pad **344***b* is disposed in contact with the grid member **223** so as to remove a discharge product adhered to the grid member **223**.

The cleaning pads **344***a* and **344***b* are each formed by, for example, bonding a nonwoven fabric onto a porous elastic base material having flexibility and then forming a powder layer over the nonwoven fabric. Examples of the elastic base material include a sponge, felt, and resin foam. The nonwoven fabric is formed by bonding fibers together or entwining fibers. The powder layer includes a mixture of an adhesive and an abrasive having a polishing function, such as alumina, carborundum, or diamond.

Each of the cleaning pads **344***a* and **344***b* may alternatively be a flocked brush-like member.

The cleaning pad **344***b* is an example of a cleaning member according to an exemplary embodiment of the present invention.

The cleaning member **343** is also provided with a pair of support members **345**, which are plate-like members. The support members **345** are disposed so as to support the grid member **223** from the lower surface thereof. When the grid member **223** is being pressed and cleaned from above by the cleaning pad **344***b*, the support members **345** prevent the grid member **223** from coming into contact with the photoconductor drum **21**. Each support member **345** has a support surface **345***a* that is in contact with the grid member **223** and that is inclined toward the cleaning pad **344***b*. The inclination angle is, for example, 10° relative to the width direction of the grid member **223** (i.e., left-right direction in FIG. **4**) when not pressed by the cleaning pad **344***b*.

The support members **345** are an example of a support member according to an exemplary embodiment of the present invention.

The support frame **341** is also provided with a pair of protruding arms **346**, which are plate-like members. The two protruding arms **346** protrude from a guide groove, which is formed at the top of the charge container **221** and extends in the longitudinal direction thereof, and are slidably movable. A drive transmission tube **347** is provided at the tip ends of the protruding arms **346**. The drive transmission tube **347** is a tubular member with a helical groove formed therein. The cleaner shaft **33** is screwed into the drive transmission tube **347**. When the cleaner shaft **33** rotates by receiving a driving force from the motor (not shown), the cleaning device **34** moves in the axial direction of the cleaner shaft **33** (that is, the longitudinal direction of the charge container **221**).

Two guide plates **348**, which are plate-like members, respectively protrude from opposite sides of the protruding arms **346**. The two guide plates **348** are disposed above the support frame **341** with a certain gap from the top thereof. The top of the charge container **221** is disposed in this gap in a slidably movable manner.

Moreover, sidewalls of the support frame **341** are provided with a pair of tilt shafts **349**. The two tilt shafts **349** are coupled to a tiltable arm **350** within the support frame **341**. A cleaning pad (not shown) is attached to a lower surface of the tiltable arm **350**. The configuration of this cleaning pad is the same as those of the cleaning pads **344***a* and **344***b*. The tiltable arm **350** is biased downward by a bias spring **351**. As a result, the cleaning pad presses against the discharge wires **222** from above while removing discharge products adhered to the discharge wires **222**.

Of the components described above, an assembly constituted of the support frame **341**, the cleaning member **343**, and the protruding arms **346** is an example of a device body according to an exemplary embodiment of the present invention. Furthermore, of the components described above, an assembly constituted of the charging device **22** and the cleaning mechanism C is an example of a charging unit according to an exemplary embodiment of the present invention.

FIG. **9** illustrates the relationship between the cleaning member **343** and the grid member **223**. The example shown in FIG. **9** illustrates a state where the grid member **223** is being cleaned by the cleaning device **34**. Specifically, side portions of the grid member **223** are supported from below by the support members **345** (specifically, the support surfaces **345***a*), and the upper surface of the grid member **223** is pressed and cleaned by the cleaning pad **344***b*. In this state, the grid member **223**, which is normally flat, is pressed by the cleaning pad **344***b* so as to be bent toward the photoconductor drum **21** (not shown). Because the support surfaces **345***a* are inclined, as mentioned above, the mesh portion **2232** and the non-mesh portion **2233** of the grid member **223** are both in contact with the support surfaces **345***a*.

FIG. **10** illustrates the relationship between the cleaning member **343** and the grid member **223** as a comparative example. The cleaning member **343** shown in FIG. **10** differs from that in the example shown in FIG. **9** in that support surfaces **345***a*' thereof are not inclined and are thus flat. Although this example also illustrates a state where the grid member **223** is being cleaned by the cleaning device **34**, the grid member **223** that is bent by being pressed by the cleaning pad **344***b* is in contact with the support members **345** only at points P since the support surfaces **345***a*' are not inclined. Since the contact area between the grid member **223** and the support members **345** in this example is smaller than that in the example shown in FIG. **9**, the contact pressure applied to the points P is larger, as compared with the example shown in FIG. **9**.

When the support members **345** move while being in contact with the mesh portion **2232** of the grid member **223**, shavings are undesirably produced at the contact regions. This is because the mesh portion **2232** of the grid member **223** has a repeating hexagonal hole pattern, as mentioned above. If the shavings fall on the photoconductor drum **21** and enter the developing device **24**, an image defect, such as a color streak or a white streak, may occur. Because the contact pressure applied to a single point of each support member **345** is larger in the example shown in FIG. **10**, the amount of shavings produced is greater than that in the example shown in FIG. **9**, resulting in a higher possibility of the occurrence of an image detect.

One conceivable method of reducing such shavings is preventing the support members **345** from coming into contact with the mesh portion **2232**. An example of such a conceivable method includes reducing the protruding length of the

support members **345** as compared with the example shown in FIG. **9**, as shown in FIG. **11**, or increasing the width of the non-mesh portion **2233** of the grid member **223** as compared with the example shown in FIG. **9**, as shown in FIG. **12**. However, if the support members **345** have the configuration shown in FIG. **11**, the contact area between the support members **345** and the grid member **223** becomes smaller than that in the example shown in FIG. **9**, making it difficult to stably support the grid member **223**, as compared with the example shown in FIG. **9**. If the non-mesh portion **2233** of the grid member **223** has the configuration shown in FIG. **12**, an area that the mesh portion **2232** occupies the grid member **223** becomes smaller than that in the example shown in FIG. **9**. This may be problematic in that the charging efficiency is lowered, as compared with the example shown in FIG. **9**. If the same area of the mesh portion **2232** as in the example in FIG. **9** is to be ensured for preventing reduced charging efficiency, the charging device **22** would undesirably become larger in size than that in the example in FIG. **9**.

Due to the above reasons, it is conceivable that the occurrence of shavings may be effectively minimized by reducing the contact pressure applied to contact points between the support members **345** and the mesh portion **2232** rather than preventing the support members **345** from being in contact with the mesh portion **2232**. Specifically, the contact pressure may be reduced by setting the support members **345** in contact with both the mesh portion **2232** and the non-mesh portion **2233**.

The inclination angle of the support surfaces **345***a* of the support members **345** may be set in accordance with the curvature of the grid member **223** that is pressed and bent by the cleaning pad **344***b*. For example, referring to FIG. **13**, if the grid member **223** is bent by a large amount, the support surfaces **345***a* may be given an inclination angle that is larger than that in the example in FIG. **9**. In this case, of the components constituting the grid member **223**, the mesh portion **2232** has a shape with a higher tendency to produce shavings than the non-mesh portion **2233**. Therefore, as shown in FIG. **13**, the inclination angle of the support surfaces **345***a* may be set such that the contact pressure applied to areas of the support surfaces **345***a* that are in contact with the mesh portion **2232** is smaller than the contact pressure applied to areas of the support surfaces **345***a* that are in contact with the non-mesh portion **2233**.

As an alternative to the support surfaces **345***a* that are inclined as shown in FIG. **9**, the support members **345** may have stepped support surfaces **345***a*" as shown in FIG. **14**. In this case, areas of the support surfaces **345***a*" that are in contact with the mesh portion **2232** may be beveled. Furthermore, the number of steps in each stepped support surface **345***a*" may be three or more.

The foregoing description of the exemplary embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

What is claimed is:

1. A cleaning device comprising:

a device body that is configured to move in a longitudinal direction of a plate-like grid member of a charging device;

a cleaning member that is disposed in the device body and cleans a first face of the grid member while pressing against the first face when the device body is moved; and

a support member that is provided in the device body and comprising an inclined support surface that is in contact with and configured to support a second face opposite to the first face of the grid member pressed by the cleaning member, the inclined support surface being in contact with a mesh portion and a non-mesh portion of the grid member, wherein the inclined support surface is inclined relative to a width direction of the grid member.

2. The cleaning device according to claim **1**, wherein the inclined support surface is inclined relative to a width direction of the grid member when not pressed by the cleaning member.

3. The cleaning device according to claim **2**, wherein an inclination angle of the inclined support surface is set such that contact pressure applied to an area of the inclined support surface that is in contact with the mesh portion of the grid member is smaller than contact pressure applied to an area of the inclined support surface that is in contact with the non-mesh portion of the grid member.

4. A charging unit comprising:

a unit body;

the cleaning device according to claim **1** that is disposed within the unit body;

a grid member that is disposed in a longitudinal direction of the unit body and is cleaned by the cleaning member of the cleaning device; and

a discharge member that is disposed in the longitudinal direction of the unit body and releases electric charge to an image bearing member via the grid member.

5. An image bearing unit comprising:

the charging unit according to claim **4**;

an image bearing member that is supplied with electric charge from the discharge member of the charging unit and that bears an image; and

a cleaning unit that cleans a surface of the image bearing member.

6. An image forming apparatus comprising:

the image bearing unit according to claim **5**;

an exposure device that exposes a surface of the image bearing member of the image bearing unit to light so as to form a latent image;

a developing device that develops the latent image formed on the surface of the image bearing member by the exposure device;

a transfer member that transfers the image formed on the surface of the image bearing member by the developing device onto a recording medium; and

a fixing device that fixes the image transferred to the recording medium by the transfer member onto the recording medium.

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